Claims

1. A data communication receiver for receiving at least one data packet, wherein the at least one data packet has a variety of inherent offsets, the data communication receiver comprising:

an input coupled to receive the at least one data packet; and

a plurality of offset estimators coupled to the input, the plurality of offset estimators comprising:

at least one of the plurality of offset estimators for estimating at least one of the variety of inherent offsets from at least a received portion of the at least one data packet while the at least one data packet is being received, and the at least one of the plurality of offset estimators having an output for providing an estimate of the at least one of the variety of inherent offsets; and

at least another one of the plurality of offset estimators coupled to the output of the at least one of the plurality of offset estimators, the at least another one of the plurality of offset estimators for estimating at least another one of the variety of inherent offsets from the at least the received portion of the at least one data packet while the at least one data packet is being received and from the estimate of the at least one of the variety of inherent offsets, and the at least another one of the plurality of offset estimators having an output for providing an estimate of the at least another one of the variety of inherent offsets.

2. A data communication receiver in accordance with claim 1 further comprising a compensator,

wherein the compensator is coupled to the input for receiving the at least one data packet, coupled to the output of the at least one of the plurality of offset estimators for receiving the estimate of the at least one of the variety of inherent offsets, and coupled to the output of the at least another one of the plurality of offset estimators for receiving the estimate of the at least another one of the variety of inherent offsets, the

compensator for compensating the at least one of the variety of inherent offsets of the data packet using the estimate of the at least one of the variety of inherent offsets, the compensator for compensating the at least another one of the variety of inherent offsets of the data packet using the estimate of the at least another one of the variety of inherent offsets, and the compensator for producing a compensated data packet; and

an output coupled to the compensator for providing the compensated data packet corresponding to the at least one data packet.

3. A data communication receiver in accordance with claim 1 wherein the at least one of the plurality of offset estimators comprises a direct current offset estimator, the direct current offset estimator for estimating a direct current offset from the at least the received portion of the at least one data packet while the at least one data packet is being received, and the direct current offset estimator for providing an estimate of the direct current offset of the at least one data packet.

4. A data communication receiver in accordance with claim 3 wherein the at least another one of the plurality of offset estimators comprises a frequency offset estimator coupled to receive the estimate of the direct current offset of the at least one data packet from the direct current offset estimator, the frequency offset estimator for estimating a frequency offset from the at least the received portion of the at least one data packet while the at least one data packet is being received and from the estimate of the direct current offset of the at least one data packet, and the frequency offset estimator for providing an estimate of the frequency offset of the at least one data packet.

5. A data communication receiver in accordance with claim 3 wherein the frequency offset estimator comprises:

an input for receiving samples of the at least one data packet;

a memory module coupled to the input, the memory module for storing a predetermined number of the samples of at least an initial portion of the at least one data packet, and the memory module for providing at least the stored samples;

a complex conjugation module coupled to receive the stored samples, the complex conjugation module for determining complex conjugation of the stored samples, and for providing complex conjugated samples;

a multiplier coupled to the input and coupled to the complex conjugation module, the multiplier for multiplying the samples of the at least one data packet and the complex conjugated samples to produce multiplied samples;

an averaging module coupled to receive the multiplied samples, the averaging module for averaging the multiplied samples by another predetermined number, and for providing averaged samples;

an argument divider module coupled to receive the averaged samples, the argument divider for determining the argument of the averaged samples, for dividing the argument by the predetermined number, and for providing the quotient;

an adder coupled to receive the estimate of the direct current offset of the at least one data packet, the adder for adding a predetermined constant to the estimate of the direct current offset, and the adder for producing added direct current offset;

another multiplier coupled to the adder and the argument divider module, the another multiplier for multiplying the added direct current offset and the quotient to produce the estimate of the frequency offset of the at least one data packet; and

an output coupled to the another multiplier for providing the estimate of the frequency offset of the at least one data packet.

6. A data communication receiver in accordance with claim 3 wherein the frequency offset estimator comprises:

an input for receiving samples of the at least one data packet;

a memory module coupled to the input, the memory module for storing a predetermined number of the samples of at least an initial portion of the at least one data packet, and the memory module for providing at least the stored samples;

a complex conjugation module coupled to receive the stored samples, the complex conjugation module for determining complex conjugation of the stored samples, and for providing complex conjugated samples;

a multiplier coupled to the input and coupled to the complex conjugation module, the multiplier for multiplying the samples of the at least one data packet and the complex conjugated samples to produce multiplied samples;

an averaging module coupled to receive the multiplied samples, the averaging module for averaging the multiplied samples by another predetermined number, and for providing averaged samples;

a subtractor coupled to the averaging module and the direct current offset estimator for combining the averaged samples and the estimate of the direct current offset of the at least one data packet, and the subtractor for producing a subtracted result;

an argument divider module coupled to receive the subtracted result, the argument divider module for determining the argument of the subtracted result, and for dividing the argument by the predetermined number to produce the estimate of the frequency offset of the at least one data packet; and

an output coupled to the argument divider module for providing the estimate of the frequency offset of the at least one data packet.

7. A data communication receiver for receiving data packets, the data communication receiver comprising:

an input coupled to receive at least one data packet, wherein the at least one data packet has a variety of inherent offsets;

at least one offset estimator for estimating at least one of the variety of inherent offsets from at least a received portion of the at least one data packet while the at least one data packet is being received, and the at least one offset estimator having an output for providing an estimate of the at least one of the variety of inherent offsets;

at least one compensator coupled to the input for receiving the at least one data packet, and coupled to the output of the at least one offset estimator for receiving the estimate of the at least one of the variety of inherent offsets, the at least one compensator for compensating the at least one of the variety of inherent offsets of the data packet using the estimate of the at least one of the variety of inherent offsets to produce at least a portion of a partially compensated data packet, and wherein the at least one compensator has an output for providing the at least the portion of the partially compensated data packet corresponding to the at least one data packet;

a plurality of offset estimators coupled to the output of the at least one compensator, the plurality of offset estimators comprising:

at least one of the plurality of offset estimators for estimating the at least one of the variety of inherent offsets from the at least the portion of the partially compensated data packet while the at least the portion of the partially compensated data packet is being received, and the at least one of the plurality of offset estimators having an output for providing an estimate of the at least one of the variety of inherent offsets; and

at least another one of the plurality of offset estimators coupled to the output of the at least one of the plurality of offset estimators, the at least another one of the plurality of offset estimators for estimating at least another one of the variety of inherent offsets from the at least the portion of the partially compensated data packet while the at least the portion of the partially compensated data packet is being received, and from the estimate of the at least one of the variety of inherent offsets, and the at least another one of the plurality of offset

estimators having an output for providing an estimate of the at least another one of the variety of inherent offsets.

8. A data communication receiver in accordance with claim 7 further comprises another compensator,

wherein the another compensator is coupled to the output of the at least one compensator, the another compensator for receiving the at least the portion of the partially compensated data packet, the another compensator coupled to the output of the at least one of the plurality of offset estimators for receiving the estimate of the at least one of the variety of inherent offsets, and coupled to the output of the at least another one of the plurality of offset estimators for receiving the estimate of the at least another one of the variety of inherent offsets, the another compensator for compensating the at least one of the variety of inherent offsets of the data packet using the estimate of the at least one of the variety of inherent offsets, and for compensating the at least another one of the variety of inherent offsets of the data packet using the estimate of the at least another one of the variety of inherent offsets, to produce a further compensated data packet; and

an output coupled to the another compensator for providing the further compensated data packet corresponding to the at least one data packet.

9. A data communication receiver in accordance with claim 7 wherein the at least one offset estimator comprises at least one direct current offset estimator, the at least one direct current offset estimator for estimating a direct current offset from the at least the received portion of the at least one data packet while the at least one data packet is being received, and the at least one direct current offset estimator for providing an estimate of the direct current offset of the at least one data packet.

10. A data communication receiver in accordance with claim 9 wherein the at least one compensator comprises at least one direct current offset compensator, the at least one direct current offset compensator for receiving the estimate of the direct current offset of the at least one data packet, the at least one direct current offset compensator for compensating the direct current offset of the at least one data packet using the estimate of the direct current offset of the at least one data packet, and the at least one direct current compensator for producing at least a portion of a partially direct current compensated data packet.

11. A data communication receiver in accordance with claim 10 wherein the at least one of the plurality of offset estimators comprises at least another direct current estimator, the at least another direct current estimator for estimating direct current offset from the at least the portion of the partially direct current compensated data packet while the at least the portion of the partially direct current compensated data packet is being received, and for providing an estimate of direct current offset of the partially direct current compensated data packet.

12. A data communication receiver in accordance with claim 11 wherein the at least another one of the plurality of offset estimators comprises at least one frequency offset estimator, the at least one frequency offset estimator coupled to the output of the at least another direct current estimator, the at least one frequency offset estimator for estimating frequency offset from the at least the portion of the partially direct current compensated data packet while the at least the portion of the partially direct current compensated data packet is being received, and the at least one frequency offset estimator for providing an estimate of the frequency offset of the partially direct current compensated data packet.

13. A data communication receiver in accordance with claim 12 wherein the another compensator comprises at least one direct current and frequency offset compensator, the at least one direct current and frequency offset compensator for receiving the estimate of the direct current offset of the partially direct current compensated data packet and the estimate of the frequency offset of the partially direct current compensated data packet, for compensating the at least the portion of the partially direct current compensated data packet using the estimate of the direct current offset of the partially direct current compensated data packet and the estimate of the frequency offset of the partially direct current compensated data packet, and for producing the further compensated data packet corresponding to the at least one data packet.

14. A frequency offset estimator comprising:

an input for receiving at least one data packet, wherein the data packet has at least a direct current offset and a frequency offset:

an input for receiving an estimate of the direct current offset; and

an output for providing an estimate of the frequency offset.

15. A frequency offset estimator in accordance with claim 14 comprising:

the input for receiving samples of the at least one data packet;

a memory module coupled to the input, the memory module for storing a predetermined number of the samples of at least an initial portion of the at least one data packet, and the memory module for providing at least the stored samples;

a complex conjugation module coupled to receive the stored samples, the complex conjugation module for determining complex conjugation of the stored samples, and for providing complex conjugated samples;

a multiplier coupled to the input and coupled to the complex conjugation module, the multiplier for multiplying the samples of the at

least one data packet and the complex conjugated samples to produce multiplied samples;

an averaging module coupled to receive the multiplied samples, the averaging module for averaging the multiplied samples by another predetermined number, and for providing averaged samples;

an argument divider module coupled to receive the averaged samples, the argument divider for determining the argument of the averaged samples, for dividing the argument by the negative value of the predetermined number, and for providing the quotient;

an adder coupled to receive the estimate of the direct current offset of the at least one data packet, the adder for adding a predetermined constant to the estimate of the direct current offset, and the adder for producing added direct current offset;

another multiplier coupled to the adder and the argument divider module, the another multiplier for multiplying the added direct current offset and the quotient to produce the estimate of the frequency offset of the at least one data packet; and

the output coupled to the another multiplier for providing the estimate of the frequency offset of the at least one data packet.

16. A frequency offset estimator in accordance with claim 14 comprising:

the input for receiving samples of the at least one data packet;

a memory module coupled to the input, the memory module for storing a predetermined number of the samples of at least an initial portion of the at least one data packet, and the memory module for providing at least the stored samples;

a complex conjugation module coupled to receive the stored samples, the complex conjugation module for determining complex conjugation of the stored samples, and for providing complex conjugated samples;

a multiplier coupled to the input and coupled to the complex conjugation module, the multiplier for multiplying the samples of the at least one data packet and the complex conjugated samples to produce multiplied samples;

an averaging module coupled to receive the multiplied samples, the averaging module for averaging the multiplied samples by another predetermined number, and for providing averaged samples;

a subtractor coupled to the averaging module and the direct current offset estimator for combining the averaged samples and the estimate of the direct current offset of the at least one data packet, and the subtractor for producing a subtracted result;

an argument divider module coupled to receive the subtracted result, the argument divider module for determining the argument of the subtracted result, and for dividing the argument by the negative value of the predetermined number to produce the estimate of the frequency offset of the at least one data packet; and

the output coupled to the argument divider module for providing the estimate of the frequency offset of the at least one data packet.

17. A method for offset compensation comprising the steps of:

a) determining at least one data packet is being received;

b) estimating direct current offset of the at least one data packet to produce an estimate of direct current offset;

c) estimating frequency offset of the at least one data packet using the estimate of direct current offset;

d) compensating the at least one data packet using the estimate of direct current offset and an estimate of frequency offset to produce a compensated data packet;

e) providing the compensated data packet corresponding to the at least one data packet.

18. A method in accordance with claim 17, further comprising performing steps (b) and (c) substantially concurrently while the at least one data packet is being received.

19. A method in accordance with claim 17, further comprising performing step (d) while the at least one data packet is being received.

21. A method in accordance with claim 17, further comprising performing step (d) after the at least one data packet has been received.

22. A method in accordance with claim 17, prior to step (a) comprising the steps of:

determining at least another data packet corresponding to the at least one data packet is being received;

estimating direct current offset of the at least another data packet to produce another estimate of direct current offset; and

compensating the at least another data packet using the another estimate of direct current offset to produce the at least one data packet.

23. A method for frequency offset estimation comprising the steps of:

a) determining samples of at least one data packet are being received;

b) determining direct current offset power using the samples of the at least one data packet;

c) adding a predetermined constant to the direct current offset power;

d) storing a predetermined number of the samples of the at least one data packet;

e) performing complex conjugation on the predetermined number of the samples to produce a result;

f) multiply the result of the complex conjugation with the samples of the at least one data packet to produce an output;

g) determine the average of the output from step (f) by another predetermined number to provide an average;

h) determine argument of the average and divide the argument by the negative value of the predetermined number to produce a resulting quotient; and

i) multiply the resulting quotient by the sum of the constant and the direct current offset power determined in step (c) to produce a frequency offset estimate.

24. A method for frequency offset estimation comprising the steps of:

a) determining samples of at least one data packet are being received;

b) determining direct current offset power using the samples of the at least one data packet;

c) storing a predetermined number of the samples of the at least one data packet;

d) performing complex conjugation on the predetermined number of the samples to produce a result;

e) multiply the result of the complex conjugation with the samples of the at least one data packet to produce an output;

f) determine the average of the output from step (e) by another predetermined number to provide an average;

g) combine the direct current offset power from step (b) with the average from step (f) by subtraction;

h) determine argument of the result of subtraction from step (g) and divide the argument by the negative value of the predetermined number to produce a frequency offset estimate.